5

10

15

20

25

## WHAT IS CLAIMED IS:

1. A method, comprising:

exposing a photo-sensitive medium to an optical intensity pattern while the medium is maintained in a condition that inhibits or prevents the optical intensity pattern from producing refractive index changes in the medium; and

then, heating the exposed medium to stimulate a pattern of refractive index changes that is responsive to the optical intensity pattern during the exposing.

- 2. The method of claim 1, wherein the condition includes that a temperature of the medium is lower than a temperature of the medium during the heating.
  - 3. The method of claim 1, further comprising:
    exposing one or more points or lines in the medium with light that causes photochemical reactions in the medium via multiple-photon absorption events.
  - 4. The method of claim 1, wherein the heating produces the pattern of refractive index changes by causing a chemical reaction selected from the group consisting of polymerization of oligomers, stimulating deprotection of portions of polymers, and stimulating crosslinking of polymers.
  - 5. The method of claim 1, wherein the medium includes a concentration of molecules that are able to neutralize photo-chemical reaction products produced by the exposing, the products being able to stimulate the chemical reaction the produces the pattern of refractive index changes.
  - 6. The method of claim 1, wherein the optical intensity pattern is produced by interfering at least three mutually coherent light beams.
- 7. The method of claim 6, wherein the pattern of refractive index changes tracks the optical intensity pattern.

10

15

20

30

- 8. The method of claim 6, wherein the heating causes refractive index changing reactions in regions of the medium where the exposing activated photosensitizer molecules dispersed in the medium.
- 5 9. The method of claim 6, wherein the heating includes heating the medium to a temperature of a rubber-like phase.
  - 10. The method of claim 6, wherein the heating produces a pattern of refractive index changes that is periodic and non-constant in three independent directions.
    - 11. A photo-sensitive composition, comprising:

a medium capable of undergoing a refractive index changing chemical reaction, the medium further comprising:

photo-sensitizer molecules dispersed in the medium, the photo-sensitizer molecules to stimulate photo-chemical reactions in response to being exposed to light, products of the photo-chemical reactions being able to stimulate the refractive index changing chemical reaction; and

neutralizer molecules dispersed in the medium, the neutralizer molecules being able to neutralize a portion of the products of the photo-chemical reactions.

- 12. The composition of claim 11, wherein one of the products and neutralizer molecules is an acid and the other of the products and the neutralizer molecules is a base.
- 13. The composition of claim 11, wherein the photoresist has a rubber-like phase, the index changing reactions being inhibited or prevented at temperatures below a transition temperature for the phase.
  - 14. A method for making crystalline structures and devices, comprising: providing a medium with photo-sensitizer molecules dispersed therein, the photo-sensitizer molecules to catalyze photo-chemical reactions in response to being activated

5

10

15

20

by light of a wavelength, products of the photo-chemical reactions being able to stimulate refractive index changes in the medium; and

exposing the medium to an optical interference pattern that is produced by combining a plurality of mutually coherent beams of light of the wavelength, the exposing being done at a temperature that inhibits or prevents the products of the photochemical reactions from causing the refractive index changes.

- 15. The method of claim 14, wherein the providing a medium includes providing a medium with a concentration of molecules to neutralize a portion of the products, the neutralized portion of the products being unable to cause refractive index changes in the medium.
  - 16. The method of claim 14, further comprising:

heating the exposed medium to stimulate the products to cause refractive index changes in the medium.

- 17. The method of claim 16, wherein the photo-sensitizer molecules are visible dye molecules and the products cause polymerization, deprotection, or crosslinking reactions in the medium in response to the heating.
- 18. The method of claim 16, wherein the heating produces an interconnected open polymerized structure.